



香港統計學會

Hong Kong Statistical Society

c/o Department of Statistics & Actuarial Science,  
The University of Hong Kong, Pokfulam Road, Hong Kong  
<http://www.hkss.org.hk>

Bulletin  
Volume 31 No. 1  
June 2008

## Editor's Foreword

I would like to express our special thanks to all contributors in this Bulletin. Their contributions are the core elements to the Bulletin. I hope members would give us your continuous support and feedback.

In this issue, apart from our President's Forum, we have a speech summary on "Challenges and Opportunities of Statistics in the 21st Century" delivered by the President of the International Statistical Institute, Professor Denise Lievesley. Those members, who missed this speech on 31 January 2008, may have a chance to get some ideas on the challenges and opportunities of Statistics in the 21st century in this issue.

Mr. King Chi Hung from the Department of Statistics, The Chinese University of Hong Kong, presented his empirical study results on "Robust Testing of Non-linear SETAR Models". Members may find the article interesting, useful and worthy to further investigation.

Statistical Project Competition for Secondary School Students has entered into its 22<sup>nd</sup> round, and it is the first time to co-organize with the Education Bureau to

this event this year. It was very successful and encouraging; a total of 1,095 students from 72 secondary schools participated in the competition. Mr. Simon Yeung, the chairperson, Organising Committee of 2007/08 Statistical Project Competition, gave us a very comprehensive report on this event.

As we all know, the Gross Domestic Product (GDP) measures the total production of goods and services of an economy. The change in the volume measure of GDP is an important indicator of the real growth of the economy. Miss Winnie K M TAM, Census and Statistics Department, presents in her article the Chain Volume Measures of Hong Kong's Gross Domestic Product, its advantages and the method to compile the Chain Volume Measures in practice.

Lastly, we can find a celebration event summary of the 40th Anniversary Dinner, Department of Statistics and Actuarial Science, The University of Hong Kong, in the News section of this bulletin.

W.L. Wong

Editor	: WONG, Raymond Wing-lit, HKU	Phone 2857 8324	Fax 2857 8326	E-mail <a href="mailto:rwong@hku.hk">rwong@hku.hk</a>
Secretary	: LAM, John Hon-kwan, C&SD	2802 1267	2121 8296	<a href="mailto:jhklam@censtatd.gov.hk">jhklam@censtatd.gov.hk</a>

## CONTENTS

(Vol. 31/No.1, June 2008)

	Page
President's Forum	1
<i>Leslie TANG</i>	
Seminar on "Challenges and Opportunities of Statistics in the 21 <sup>st</sup> Century"	4
by the President of the International Statistical Institute	
<i>Simon YEUNG and Christine CHEUNG</i>	
Robust Testing of Non-linear SETAR Models: an Empirical Study	8
<i>King Chi HUNG</i>	
Chain Volume Measures of Hong Kong's Gross Domestic Product	15
<i>Winnie TAM</i>	
2007/08 Statistical Project Competition for Secondary School Students	19
<i>Simon YEUNG</i>	
News	23

## President's Forum

*Leslie TANG*

I am honoured to have the opportunity to say a few words in this forum again.

In the past few months, the Society has organized a number of activities to help members to keep abreast of the latest statistics development. Besides, the Society has also established closer relationship with statistical organizations in the Mainland as well as those at international level.

Firstly, in collaboration with the Census and Statistics Department and Department of Statistics and Actuarial Science of the University of Hong Kong, we invited Prof Denise Lievesley, the President of the International Statistical Institute (ISI), to deliver a speech on “Challenges and Opportunity of Statistics in the 21<sup>st</sup> Century” whilst she visited Hong Kong in Jan 2008.

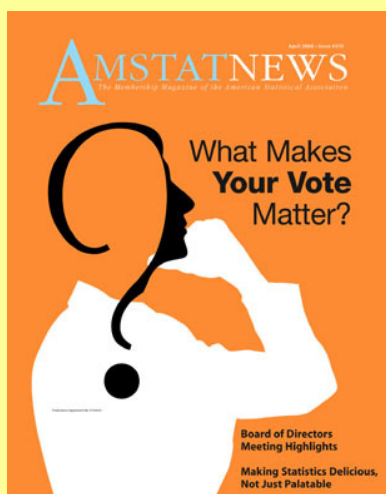


In the seminar, Prof Lievesley gave us many insights on how we could enhance the use of statistics for evidenced-based decisions. She also highlighted the areas through which academics, statistical practitioners and researchers would work together to take on the challenges in the 21st century.

Prof Lievesley had substantial experience in both national and international statistical work. She had been the Chief Executive of the Health and Social Care Information Centre in the UK, President of the Royal Statistical Society, and Director of Statistics at the United Nations Educational, Scientific and Cultural Organization (UNESCO).

For those who missed the seminar, please see page 4 of this Bulletin for more details of the seminar.

Secondly, we had contributed an article, “Society Marks 30 Years of Promoting Stats” in the April 2008 issue of *Amstat News*, the membership magazine of the American Statistical Association.



In the article, we highlighted the many activities we had organized to celebrate the 30<sup>th</sup> anniversary of the Society. The academic seminars entitled “Economic Time Series” and “Statistics in Finance and Economics”, and the one on “Evaluation of Global Economic Models” given by Sir Clive Granger, the 2003 Nobel Laureate in Economics were mentioned. Moreover, the article also briefly described the statistical literacy promotion activities conducted by the Society, including organization of a public seminar on “Sample Surveys: How to be a Smart Data User” and uploading of the booklet *A Practical Guide to Sample Surveys* written by our members onto our website. Positive feedback was received after the release of the article in this international statistical publication.

Thirdly, our Society stands ready to render full support to the Census and Statistics Department in organizing the 59<sup>th</sup> Session of the International Statistical Institute (ISI) in Hong Kong in 2013.

The ISI is a prestigious, international and professional association of statisticians which seeks to develop and improve statistical methods and their applications through promotion of international activities and co-operation. Its membership crosses all borders, representing more than 130 countries worldwide.



The biennial Session of the ISI is regarded as the Statistics Olympiad internationally. About 2 000 delegates from all over the world attend the Session in each round. It is a great pleasure for Hong Kong’s statistical community to have won the bid for hosting the 59<sup>th</sup> Session.

Fourthly, a delegate of 32 statistical professionals from the Jiangsu Province visited our Society in May 2008. During the exchange, we noted that they were



particularly interested in our work on promotion of statistical literacy in Hong Kong, organization of professional statistical examinations and establishment of relationship with other advanced national and international statistical organizations. In that occasion, they also shared with us the organization and work of the statistical society of Jiangsu Province. Both sides found the discussion informative and fruitful.

Mournfully, I regret to report that Mr George Yeung, a senior and active member of the Society, passed away on 8 June. George started his statistical career at the Census and Statistics Department in early 1980's, and was a Senior Statistician outposted to the Food and Health Bureau before his death. He has served as the General Secretary of the Society, and has made a lot of contributions to the development of the Society, such as organization of Secondary Project Competition and planning of the incorporation of the Society. His death is a loss for the statistical community of Hong Kong. We express our sincere condolences to his family.

**Seminar on**  
**“Challenges and Opportunities of Statistics in the 21<sup>st</sup> Century”**  
**By the President of the International Statistical Institute**

*Mr. Simon WT YEUNG and Ms. Christine MC CHEUNG*  
*Census and Statistics Department*



Department of Statistics and Actuarial Science  
The University of Hong Kong



Census and Statistics Department



Hong Kong Statistical Society

### Introduction

The Hong Kong Statistical Society (HKSS), the Census and Statistics Department (C&SD), and the Department of Statistics and Actuarial Science of the University of Hong Kong jointly organized a seminar on “Challenges and Opportunities of Statistics in the 21<sup>st</sup> Century” on 31 January 2008 at the University of Hong Kong. It was one of the activities to jointly celebrate the 40<sup>th</sup> anniversary of the C&SD, the 40<sup>th</sup> anniversary of the Department of Statistics and Actuarial Science of the University of Hong Kong, and the 30<sup>th</sup> anniversary of the HKSS. The President of the International Statistical Institute (ISI), Professor Denise LIEVESLEY, was the speaker of this event. The Seminar attracted about 200 participants from various sectors of the community, in particular academics and statistical practitioners.

In the welcoming remarks, Professor LI Wai-keung, Chair and Head of the Department of Statistics and Actuarial Science of the University of Hong Kong, set the stage for the Seminar by stating the crucial role that statistics play in policy and decision

making in this era of information explosion. To meet the ever increasing demand for high quality statistics, the statistical communities were tasked with challenges to identify the needs of various users of statistics and to develop strategies to meet such needs. Within this context, Professor LIEVESLEY would highlight how best to grasp the opportunities to improve the use of statistics in policy and decision making.



*Professor Denise LIEVESLEY at the tea reception*

As introduced by Mr. FUNG Hing-wang, Commissioner for Census and Statistics, the ISI was established in 1885. It was a prestigious, international and professional association of statisticians which sought to develop and improve statistical methods and their



applications through the promotion of international activities and co-operation. Its membership crossed all borders, representing more than 130 countries worldwide. The biennial Session of the ISI had often been regarded as the Statistics Olympiad by the international statistical community, for which the 59<sup>th</sup> Session would be hosted by Hong Kong in year 2013.

Mr. FUNG continued to say that Professor LIEVESLEY was the first female President of the ISI. She began her career as an official statistician in the United Kingdom (UK). She took up a number of senior posts in international statistical organizations, and national and academic institutions. These included President of the Royal Statistical Society, Director of the ISI, and Director of Statistics at the United Nations Educational, Scientific and Cultural Organization (UNESCO). She had also been the Chief Executive of the Health and Social Care Information Centre in the UK, Director of the UK Data Archive and the Professor of Research Methods in the Mathematics Department at Essex University of the UK.

Mr. FUNG remarked that Professor LIEVESLEY, who was the President of a leading international statistical association and possessed vast experience in statistical work, was the most suitable person to address the audience on the topic of this seminar.

### **The Seminar**

Professor LIEVESLEY first outlined the four themes of the seminar, including:

- (a) greater integration of data from different sources;
- (b) improving access to data, especially for research purposes;

- (c) fostering cross-national comparability; and
- (d) nurturing shared values.

The above helped to enhance the use of statistics for evidence-based decision making.



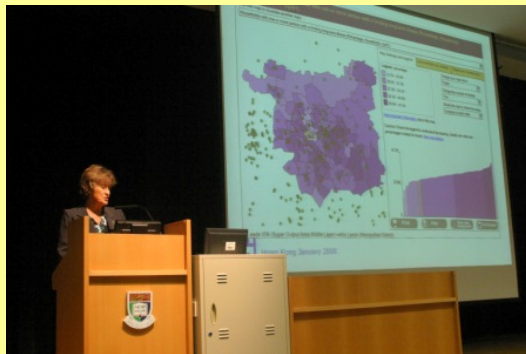
*Professor Denise LIEVESLEY introducing the themes of the Seminar*

### ***Greater integration of data from different sources***

Professor LIEVESLEY pointed out that many statistical analyses focused on a single data source. Combining data from different sources, on the contrary, could yield advantages like added values due to different perspectives as well as better understanding and heightened interest to users.

Professor LIEVESLEY suggested that data integration should be carried out at an area level rather than at an individual level. The former allowed better inference to be drawn and improved the quality of data. It also enabled users to have a better understanding of the disseminated statistics due to the rich context and different perspectives provided by various sources. An example on the Neighbourhood Statistics of the UK was given to illustrate area integration. Professor LIEVESLEY cautioned against data integration at individual level because it would touch upon confidentiality issues and there might

be insufficient overlap of individual members among different sources.



*Professor Denise LIEVESLEY giving an example on data integration*

### ***Improving access to data, especially for research purposes***

Professor LIEVESLEY suggested promoting a web of relationships among the academic, the official and other non-official statistics sectors in terms of joint research and training of personnel. Such connection could serve as a platform through which the exchange of expertise and improved access to data for research purpose would be facilitated.

Professor LIEVESLEY opined that the benefits of sharing data among members in the statistical community were immense. On the one hand, sharing data could encourage greater exploitation of data, contribute to sound policy decisions, foster multiple perspectives on data and facilitate comparable research. On the other hand, sharing data could reduce response burden. This was because secondary data analysis could take place in resource-constrained environment, saving the time and resources required to collect fresh data.

Despite the aforementioned benefits, Professor LIEVESLEY highlighted several barriers which existed to hinder data access. These mainly included confidentiality and

sensitivity of data, legal restrictions and promises made to respondents. She advised that issues on incentives as well as means to promote data access should be addressed.

### ***Fostering cross-national comparability***

Professor LIEVESLEY said that there were two purposes for fostering cross-national comparability. First, this would allow aggregation of data so as to provide a global picture for advocacy, resource mobilization and the accountability of governments. Second, this would permit meaningful comparison to be made, so that parties could learn from each other, for benchmarking and for acting as a catalyst for debate.

After giving an example on providing the global picture of 'the number of out-of-school children for the world', Professor LIEVESLEY outlined a number of difficulties in harmonising data. Differences in definitions, inclusions, exclusions, coding and classifications, and survey methods across countries were a few examples on the sources of difficulties. She proposed a number of options for harmonisation, ranging from giving explanation in footnotes for minor differences, to a change in statistical practices or processes to make up to the common standard.

### ***Nurturing shared values***

Professor LIEVESLEY addressed the importance of developing a framework of shared values for organizations as well as for individual professionals. A new sense of purposes, an ethical approach to statistical work, and an articulated culture were some essential aspects.



She quoted a few key principles from an example, including “We take risks”, “We work in the clients’ interests” and “We take action to ensure that others’ actions are incorruptible”. She also emphasized the importance of motivation at work, the nurture and maintenance of trust, better communication skills, and the demand for increased political awareness, humility, and ambition to tackle big issues, and lastly, the leadership to build better nations and ultimately a better world.

In response to a question related to data access raised during the Question-and-Answer session, Professor LIEVESLEY said that collaboration between the official agencies and the research communities could be one of the means to increase exploitation of collected data. In response to another question related to information technology (IT), Professor LIEVESLEY opined that the use of IT was becoming more crucial with the growing importance of timeliness in data dissemination. She also commented, in answering another question, that when other disciplines were performing increasingly sophisticated data collection and analyses, how to define “statisticians” would be another challenge to face.



*Professor Denise LIEVESLEY taking a question from the floor*

## Conclusion

Mr. Leslie TANG Wai-kong, the President of the HKSS, concluded the Seminar by saying that the HKSS would provide the necessary platform through which academics, statistical practitioners and researchers would work together to take on the challenges as highlighted in this stimulating seminar.



*Mr. Leslie TANG Wai-kong providing concluding remarks*

# **Robust Testing of Non-linear SETAR Models: an Empirical Study**

*King Chi HUNG*

*An MPhil student in the Department of Statistics  
The Chinese University of Hong Kong*

## **Introduction**

Non-linear time series models have been developed rapidly in recent years. It complements the deficiency of linear models in capturing some commonly observed features such as asymmetries and limit cycles. The underlying non-linearity structure can be generated by regime shifts or switches in the time series. Changes in government policy, market trading conditions or other factors are possible factors for the regime shifts and switches of behaviour in economic and financial series. Applications of non-linear model include the modeling of interest rates, annual price inflation series, and exchange rates.

Threshold autoregressive model provides a piecewise linear approximation to the general non-linear autoregressive model governed by the regime switch. *Self-exciting threshold autoregressive (SETAR) model* by Tong (1978) is a popular subclass of the threshold model in non-linear time series analysis. It is a

piecewise linear model which can effectively exhibit the structural features of jump resonance, amplitude-frequency dependency, subharmonics, higher harmonics, limit cycles and strange attractor, and synchronization in a non-linear time series (Tong, 1983). Adoption of the SETAR model in economic and financial series is very popular and in this paper, the prime objective is to use the SETAR model to model selected financial data available in Hong Kong.

## **The SETAR Model**

Denote  $k$  be the number of regimes in the model,  $p$  be an autoregressive order in each regime, and  $d$  be a delay parameter (or threshold lag) with  $d \leq p$ . The model is not identified unless all these parameters are positive integers. For a time series  $\{Y_t\}$ , the SETAR( $k; p, d$ ) model is defined by the piecewise linear autoregressive (AR) equations.

The AR equation in the  $j$ -th regime is expressed as

$$Y_t = \phi_0^{(j)} + \sum_{v=1}^p \phi_v^{(j)} Y_{t-v} + \varepsilon_t$$

if  $r_{j-1} \leq Y_{t-d} < r_j$  where  $j = 1, 2, \dots, k$ ,  $t = p+1, p+2, \dots$ , and  $\varepsilon_t \sim NID(0, \sigma^2)$ .  $\varepsilon_t$  is independent of  $Y_{t-1}, Y_{t-2}, \dots$  and  $\sigma^2 < \infty$ . Moreover,  $(k-1)$  distinct threshold parameters namely,  $r_1, r_2, \dots, r_{k-1}$ , are used to partition the observations into  $k$  non-overlapping regimes. The process is said to be stationary if all roots of the characteristic equation in each regime which is a function of the autoregressive parameters, i.e.,  $1 - \phi_1^{(j)}x - \phi_2^{(j)}x^2 - \dots - \phi_p^{(j)}x^p = 0$ , lie strictly outside the unit circle.

The introduction of the SETAR model provides a comprehensive and relatively uncomplicated modeling procedure, and enhances the ability to identify the threshold variable and to estimate the threshold values (Tsay, 1989). More precisely, the process is divided into  $k$  linear AR regimes each of order  $p$  (so-called threshold autoregressive). The interval  $r_{j-1} \leq Y_{t-d} < r_j$  is the  $j$ -th regime under which the regime shift is triggered by the values of its own past observations (so-called self-exciting). In a

generalized version of the SETAR model, different AR orders and error variances between regimes are allowed (Tong, 1983). Besides, a SETAR(1;  $p, d$ ) model is a special case of an AR( $p$ ) process. In this case, the model reduces to a linear process with only one regime.

### Tests for Threshold-type Non-linearity

This section outlines the identification of the SETAR model by means of the threshold-type non-linearity tests. The process  $\{Y_t\}$  is said to be non-linear if at least two regimes with different AR specifications exist in the process. Alternatively, the model reduces to a linear AR( $p$ ) process if  $\phi_v^{(j)} = \phi_v^{(s)}$  for all  $v = 0, 1, \dots, p$  and  $j \neq s = 1, 2, \dots, k$ .

Traditional tests for non-linearity include Petruccielli and Davies's (1986) CUSUM test, Petruccielli's (1990) RC test, Luukkonen *et al.*'s (1988) LM test, Chan and Tong's (1990) LR test, and Tsay's (1989)  $F$  tests. These tests require the AR order  $p$  and delay parameter  $d$  be fixed except for the LM test which allows  $d$  to be unknown in advance. They provide acceptable size

and power when the series is free of outliers. However, testing threshold-type non-linearity is a challenging question when the series is contaminated with outliers which may arise from heavy-tailed distributions or abnormal events which are not inherent in the process. For instance, a weekly sales series may be positively affected by a bargain month and an industrial production series may temporary decrease followed by a strike.

No single test among them is able to resist large outlying observations. Provided that the asymmetric non-linear distribution of observations among regimes is reflected in only a few observations, an asymmetric non-linear model of moderate length behaves similarly to a linear model contaminated with outliers (van Dijk *et al.*, 1999). Under linear data generation mechanism, observations coming from the regime with less observations are always misspecified as aberrant observations which are rare events probably not happening again. Standard outlier removal techniques become inappropriate in this situation. Specifically, one additive outlying observation in an AR(1) process will create one vertical outlier and one

leverage point in the planes of regression. Detection of outliers is much harder in multivariate data clouds of an AR( $p$ ) process than in the univariate case because of high dimensionality.

The failure to distinguish threshold-type non-linearity from linear model may cause serious identification problem. Recognizing a linear time series which is contaminated with outliers as a non-linear model may yield very complicated models. It captures the apparent extreme values as part of the data structure. On the contrary, treating a non-linear model as linear may destroy intrinsic non-linearity structure of the original time series which results in poor predicting power. However, realizations of the SETAR model are not as trivial as expected. To avoid misspecification, a robust approach is considered to lessen the outlier effect in the tests.

### **A Robust Test**

In the early development of the threshold model, a robustified version of the  $LM$  test was developed for the Smooth Transition Autoregressive model with the SETAR model as a special case (van Dijk *et al.*, 1999).

Unfortunately, oversized problem was found significant in the simulation.

The proposed test we suggest now is under the *stepwise arranged autoregression* approach which is inspired by Tsay's (1989)  $F$  test, however, the ordinary least squares estimators are replaced by the generalized- $M$  ( $GM$ ) estimators. First of all, the effective observations  $\{Y_t \mid t = h, h+1, \dots, n; h = \max(1, p+1-d)\}$  are arranged in ascending order according to the threshold variables. Then, the  $GM$  stepwise autoregression is performed from the startup value  $m$  ( $> p+1$ ) to obtain a set of one-step ahead forecast errors by the recursive estimates of the AR parameters. Lastly, a usual  $F$  statistic of the regression is employed on the predictive residuals and the lagged observations.

The essence of the test is attributed to the aforementioned orthogonality property. Under the null model of linearity, the predictive residuals follow a white noise process and they are uncorrelated to the lagged regressors. Using an argument similar to the usual analysis of variance, it is proved that the test statistic follows asymptotically an  $F$  distribution with degrees of freedom  $(p+1)$  and  $(n-d-h-$

$m-p)$ . The destruction of the orthogonality property in the regression would give a high  $F$  statistic which in turn indicates a significant threshold-type non-linearity.

The proposed test is simple and it only involves regression-type structure. The actual number and location of the threshold can either be known or unknown in the test. No model identification and model fitting are required. More importantly, the discriminative power of the test is enhanced in the presence of outliers.

Regression with  $GM$  estimator is also known as bounded influence regression since it utilizes weight functions to bound the influence of both the vertical outliers and leverage outliers. In our case, Schweppe-type regression makes use of the information given by good leverage points while reducing the weights of the vertical points in computing the AR coefficient estimates.

An illustration is given for a simple AR(1) model. The first-order condition for this type of regression becomes

$$\sum w_z(z_t)Y_{t-1}(Y_t - Y_{t-1}) = 0$$

where  $z_t = \frac{\varepsilon_t}{\sigma_\varepsilon w_y(Y_{t-1})}$  and  $\sigma_\varepsilon$  is a robust measure of  $Y_{t-1}$ .

Following van Dijk *et al.* (1999), the weight functions for  $w_y$  and  $w_\varepsilon$  are denoted by

$$w(u) = \psi(u)/u \text{ for } u \neq 0$$

where  $\psi(\cdot)$  is an odd and bounded function under some regularity conditions. The degrees of efficiency and robustness of the proposed test are controlled by the choice of the  $\psi$ -function together with the tuning constant(s). A common choice is the monotone Huber (3.291)  $\psi$ -function. A point beyond some rejection points will receive a constant non-unit weight so that the effect of the extreme observations is dampened. It then makes the regression become less sensitive to large changes of the observed values.

A small scale of simulation in the research reveals that the results of the proposed test with the Huber function are similar to those of the original Tsay's  $F$  test in the case of no outliers. However, when in the presence of outliers, the proposed test outperforms the original Tsay's  $F$  test in terms of high power and reasonable

size. The discriminative power of the proposed test lifts up with the size of outlier contamination and the degree of non-linearity.

### Application of the GM Test on the Financial Series in Hong Kong

Daily log-return series of the Hang Seng Index (HSI) and Hang Seng China Enterprises Index (HSCEI) on Hong King Stock Exchange are examined on threshold-type non-linearity from January 2001 to December 2007 (each with 1825 observations). Figure 1 reveals the movements of the log-returns of these two indexes in the testing period. Sample partial autocorrelation function of the observed series is used to estimate the model order  $p$  by the cut-off pattern among the first five lags. Then, the delay order  $d$  is selected from  $\{1, 2, \dots, p\}$  such that its corresponding  $p$ -value of the non-linearity test is the smallest.

The test results at the 5% level of significance are summarized in Table 1. It is seen that we cannot obtain a consistent result according to the non-robust tests. The proposed tests result in linearity in both series which are identical to those of the  $RC$



test. Based on the findings, we conclude that only one regime can be identified in the HSI and HSCEI log-return series. However, among the five non-robust tests, more than half of them show results towards non-linearity which means there is at least one regime in those log-return series.

With reference to the movement of the log-returns, there are some dramatic drops of the HSI series

in the last quarter of 2001 in Figure 1(a). At the same time, the HSCEI series experiences large variability throughout the testing period in Figure 1(b). The outbreak of SARS in Asia can account for the fluctuation of the Hong Kong stock market over year 2001. This feature becomes an obstacle for the non-linearity tests because the outlying observations might affect the performance of the non-robust tests and lead to unreliable conclusions.

Table 1: Non-linearity test results on Hong King Stock Exchange, 2001-2007

Return series	$\hat{p}$	Non-robust test					Robust test
		CUSUM	RC	LR	LM	Tsay's $F$	Proposed
HSI	3	NL	L	NL	NL	NL	L
HSCEI	1	NL	L	L	NL	NL	L

L: Result towards Linearity      NL: Result towards Non-Linearity

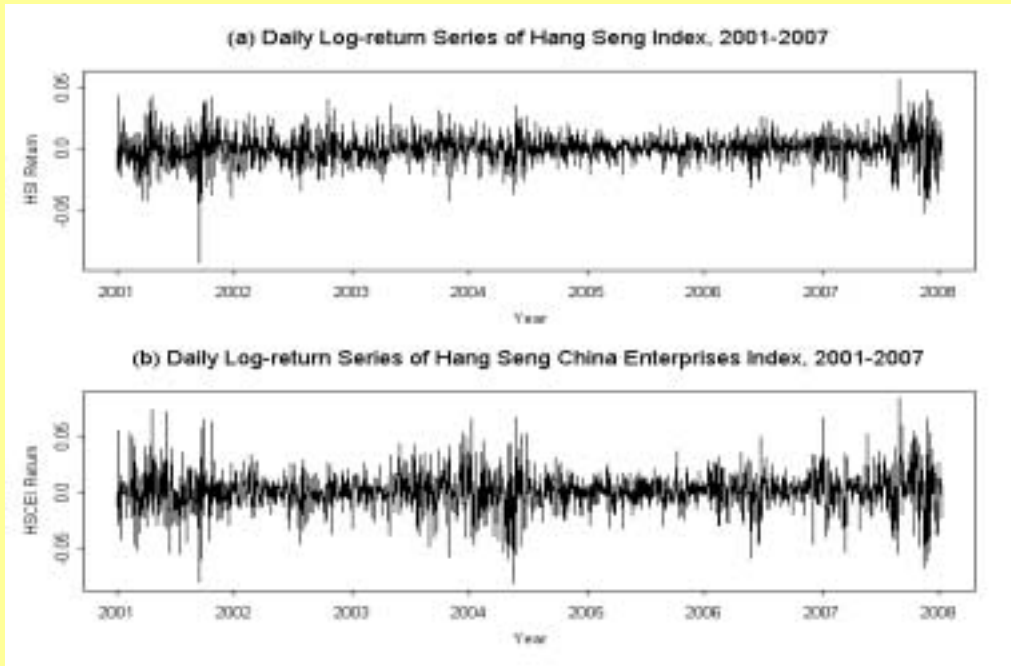


Figure 1: Daily log-return series on Hong King Stock Exchange, 2001-2007

## Conclusion

It is unavoidable to deal with outlying cases in reality especially in financial and economic data. The non-linear SETAR model provides a much wider dynamic in modeling these time series. The proposed test utilizes the robust properties of the *GM* estimator which suppresses the influence of outliers by placing less than unit weights on them.

It is seen that the performance of the non-robust tests varies with the size of the outlier contamination in the process. The non-robust tests break down easily if the process deviates from the model assumptions. Besides, the proposed test is robust and insensitive to outliers. It overcomes the oversized problem and maintains the power at a reasonably high level in detecting threshold-type non-linearity.

## References

- Chan, K.S., and Tong, H. (1990). "On likelihood ratio tests for threshold autoregression". *Journal of the Royal Statistical Society B*52: 496-476.
- Denby, L., and Martin, D. (1979). "Robust estimation of the first-order autoregressive parameter". *Journal of the American Statistical Association* 74: 140-146.
- Luukkonen, R., Saikkonen, P., and Terasvirta, T. (1988). "Testing linearity against smooth transition autoregressive models". *Biometrika* 75: 491-499.
- Petrucelli, J.D. (1990). "A comparison of tests for SETAR-type non-linearity in time series". *Journal of Forecasting* 9: 25-36.
- Tong, H. (1978). *On a Threshold Models in Pattern Recognition and Signal Processing*. (Chen, C.H. Ed.). Sijhoff and Noordhoff: Amsterdam.
- Tong, H. (1983). *Threshold Models in Non-linear Time Series Analysis (Lecture Notes in Statistics No.21)*. Springer-Verlag: New York.
- Tsay, R.S. (1989). "Testing and modelling threshold autoregressive processes". *Journal of the American Statistical Association* 84: 231-240.
- van Dijk D., Franses P.H., and Lucas A. (1999). "Testing for smooth transition nonlinearity in the presence of additive outliers". *Journal of Business & Economic Statistics* 17: 217-235.

# Chain Volume Measures of Hong Kong's Gross Domestic Product

**Winnie K M TAM**  
*Census and Statistics Department*

## Introduction

The Gross Domestic Product (GDP) measures the total production of goods and services of an economy. The change in the volume measure of GDP, sometimes known as the inflation-adjusted or real GDP, is widely used as an important macro-economic indicator of the real growth of the economy. In recent years, an increasing number of statistically advanced economies have changed over from the constant price measure of GDP to the chain volume measure of GDP in estimating the GDP in real terms. As for Hong Kong, the Census and Statistics Department (C&SD) released for the first time the chain volume measures of the GDP in October 2007 to replace the previous constant price series. This is a major milestone to further align the GDP statistics of Hong Kong with the latest international guidelines and the good practice of statistically

advanced economies. Most importantly, the adoption of the enhanced compilation method for the volume estimate of GDP provides a better measure of the real growth rate of the Hong Kong economy.

## International Guidelines on the Compilation of Volume Measures of GDP

In Hong Kong, the compilation of GDP follows the international statistical guidelines set out in the *System of National Accounts* (SNA). The previous 1968 version of the SNA (1968 SNA) promulgated the use of the fixed-weighted approach for compiling the volume measure of GDP. Such estimate is commonly referred to as the constant price measure of GDP as the price weights for aggregating the volumes of the GDP components are fixed at a selected base year.

Mathematically, the *constant price measure of GDP* can be represented by the following fixed-weighted Laspeyres volume index formula:

$$L^{t/0} = \frac{\sum_i p_i^0 q_i^t}{\sum_i p_i^0 q_i^0}$$

where:

$L^{t/0}$  is the fixed-weighted volume index of the aggregate for period  $t$  with base year  $0$

$p_i$  represents the “price” of component  $i$

$q_i$  represents the “volume” of component  $i$

Over time, the price weights in the base year may no longer be representative of the current price structure in the economy. Thus, it is a common practice to update the base year and the price weights every five to ten years. For Hong Kong's constant price GDP series, previous base years include 1966, 1973, 1980, 1990 and 2000.

As time goes by, the constant price measures of GDP which adopt the price structure of a fixed base year tend to overstate the weights of those GDP components for which relative prices have fallen or have been increasing at a slower rate, thus over-estimating their contribution to the real growth of the GDP aggregate. Furthermore, at times of drastic

economic changes and rapid movements of relative prices of different components and the associated volumes, updating the base year every five to ten years may not be sufficient to reflect the changing economic environment.

Recognizing the limitations of the fixed-weighted index approach, the latest 1993 version of the SNA (1993 SNA) recommends the adoption of the *annually re-weighted chain linking approach* for compiling the volume measures of GDP and its component aggregates. Under the new approach, the volume measure of GDP for each year is compiled by aggregating the volume estimates of its components using the price structures in the preceding year as weights.

Mathematically, the chain volume measure of GDP can be represented by the following Chain Laspeyres volume index formula:

$$L^{t/t-1} = \frac{\sum_i p_i^{t-1} q_i^t}{\sum_i p_i^{t-1} q_i^{t-1}}$$

where:

$L^{t/t-1}$  is the annually-reweighted volume index for period  $t$  with base year  $t-1$

$p_i$  represents the "price" of component  $i$

$q_i$  represents the "volume" of component  $i$

## Advantages of the Chain Linking Approach

The chain volume measure of GDP assigns to each component the most relevant weight based on information updated every year. By using the up-to-date price structures as weights in aggregating the volume estimates of the GDP components, the chain volume measure provides a better estimate of the real growth

rate of an economy.

When using the constant price method for measuring real GDP growth, rebasing is done every five to ten years and this may result in big revisions to the historical estimates of the GDP real growth rate, in particular for periods which are distant from the fixed base year. As the chain volume measure of GDP has the same effect of rebasing the constant price GDP series

every year, rebasing revisions would be of much smaller magnitude, thus helping to avoid “re-writing” the economic history.

In compiling a volume index, one practical issue to tackle is that products (e.g. walkman) are continually disappearing from the market and replaced by new products (e.g. MP3) as a result of technological progress, new discoveries, changes in tastes and fashions etc. Since the likelihood of an overlap of a product in two consecutive years is bound to be greatest, the chain volume index has the advantage of accommodating changes in weights associated with new and disappearing products.

### **Compilation Method of the Chain Volume Measures of GDP**

In compiling the chain volume measures of GDP, the two concepts of “base year” and “reference year” should be distinguished. *Base year* is the year from which the price structures are used as weights for deriving the aggregate volume measures of GDP. The base year is always the preceding year in principle and the price weights are updated every year (thus the concept of “annually re-weighted”). *Reference year* is the year to which the time series of the volume measures has been referenced. The preceding-year weighted volume measures reflect the change in volume of GDP and its components between two consecutive years. The reference year provides a reference time point for linking up the year-on-year movements of these pairs of short-term volume indices to obtain continuous time series of the GDP volume measures (thus the concept of “chain linking”).

As an illustration, in compiling the volume measure of GDP for a particular year, say 2007, volume estimates of the major components revalued at preceding year (i.e. 2006) prices are first produced by “deflating” the current price values of sub-components by the relevant price indices at the most disaggregated levels. The volume estimate of GDP for 2007 is then obtained by aggregating the volume estimates of GDP components revalued at 2006 prices.

The short-term volume index of GDP for 2007 is then calculated by dividing the volume estimate of GDP for 2007 by the current price GDP for 2006. With the effect of price changes eliminated by revaluing the 2007 values of components at 2006 prices, the short-term volume index measures the real growth of GDP of 2007 over 2006. Short-term volume indices for other years, which measure the movements of the volumes of GDP and its components compared with the preceding year, are compiled in a similar manner.

These preceding-year weighted short-term volume indices for other years are then chain linked to a selected reference year (the current reference year is 2006) in order to obtain continuous time series of the chain volume indices of GDP and its components.

### **Non-additivity Property of the Chained Dollar Estimates of GDP and its Components**

The chain linking approach results in a set of chain volume indices for GDP and its components. Some economic analyses require

data of GDP volume measures expressed in dollar terms. The chained dollar series are obtained by extrapolation of the current price GDP and its components in the reference year backward and forward using the chain volume indices as the extrapolators.

In order to preserve the historical real growth rates of GDP and its components, the chain linking process is carried out for the GDP and its components independently. As a result, the chained dollar estimates of GDP and its components are additive in the reference year and the following year but may be non-additive for the earlier periods. The extent of non-additivity is usually small for periods around the reference year and the discrepancy may enlarge as the data series move further away from the reference year.

It should be noted that the non-additivity feature of the chain volume measure arises from purely mathematical reasons; the discrepancy between the chained dollar estimate of GDP and the sum of its components should not be interpreted as an indication of the data quality of GDP statistics.

International statistical guidelines do not recommend adjustments for non-additivity of the chained dollar GDP series as this will undermine the quality of the GDP volume measures. After all, the primary purpose of compiling the volume measures of GDP is to provide a good indicator of the real growth over time of an economy.

## References

For more information on the chain volume measures of GDP, readers may refer to the *Special Report on Gross Domestic Product – Chain Volume Measures of Gross Domestic Product* available on the website of the C&SD ([www.censtatd.gov.hk](http://www.censtatd.gov.hk)).



## 2007/08 Statistical Project Competition for Secondary School Students

***Mr. Simon W T YEUNG***  
***Chairperson, Organising Committee of***  
***2007/08 Statistical Project Competition***

Entering into its 22<sup>nd</sup> round, the Statistical Project Competition (SPC) for Secondary School Students continues to serve as one of the indispensable endeavours of the Hong Kong Statistical Society (HKSS) in arousing interest of students in statistics and promoting statistical literacy in the community. With the concerted effort of the devoted members of HKSS and relevant parties, and contributions from the Patrons and Sponsor, the 2007/08 SPC had been successfully concluded.



*An eye-catching banner of the 2007/08 Statistical Project Competition for Secondary School Students, which was co-organised by the Hong Kong Statistical Society and the Education Bureau for the first time.*

Co-organised for the first time with the Education Bureau (EDB), the 2007/08 SPC received very encouraging and promising responses. A total of 1 095 students from 72 secondary schools in the territory participated in this round of SPC, compared with 993 students from 65 schools in the previous round.

Of the 224 entries received, including 110 for the Junior Section and 114 for the Senior Section, a wide array of topics of various social and economic interests was covered. The dedicated effort of the participating students could be witnessed through their study on current issues like problems in Tin Shui Wai new town and inflation, as well as other social issues such as domestic abuse and suicide. Hence, the SPC has heightened a sense of civic awareness among the secondary school students.

The adjudication panel was formed under the leadership of Dr LI Leong-kwan of the Polytechnic University of Hong Kong. It was consisted of 28 members including academics from local tertiary institutions and statistical professionals working in the government.

Having undergone stringent scrutiny by the adjudicators, and after much deliberation, the more outstanding statistical projects were shortlisted and the potential candidates were invited to attend a selection interview before the awards were finally determined.

As a feedback to all the participating teams, constructive comments were provided by the panel members after the SPC.

To persistently strive for excellence, a number of initiatives had been introduced in the 2007/08 SPC. One of which was to organise the briefing seminar cum exhibition of past winning projects at Wei Hing Theatre of the City University of Hong Kong as a means to publicize the event. This arrangement provided participants with a more spacious venue for the briefing seminar and a convenient location to peruse the past winning projects in the exhibition. The event was held successfully on 3 November 2007.

Another initiative was to upload the presentation materials of the speakers and the winning projects of past two years to the website of HKSS. On the one hand, this could meet the needs of those who could not show up at the briefing sessions. On the other hand, this could serve as handy reference of all the interested parties.

Participants of this round were required to submit an electronic application form,

which was available at the website of HKSS, in addition to the hardcopy submission. This initiative helped streamline adjudication logistics and maintain the accuracy of required information for preparing the relevant Certificates.



*Teachers and students from Chiu Lut Sau Memorial Secondary School, winners of the First Prize of the Junior Section and the Sun Hung Kai Properties Prize for the Best Thematic Project, shared their blissful moment with the Patrons and Honourable guests.*

The Prize Presentation Ceremony (the Ceremony) held on 26 April 2008 signified the successful completion of the 2007/08 SPC. Patrons and Honourable guests hosted the Ceremony and delivered enlightening speeches to the audience. At the Ceremony, the First, Second, Third and three Distinguished Prizes for each of the Junior and Senior Sections, as well as the Sun Hung Kai Properties Prize for the Best Thematic Project, were awarded to the winning teams.

Apart from trophies and the latest statistical publications, the winning teams

also received, for the first time, book coupons instead of cheques issued by HKSS. As an indication of support to the SPC, the Commercial Press (H.K.) Limited had offered a discount on the book coupons purchased.

The more unprecedented attempt was that the First Prize winner of each Section was awarded a shield carved with the school name and those of all previous champions of the SPC. The champion of each Section could retain the shield for a year.



*The First Prize winner of the Junior and Senior Section was each awarded a shield on which the school name and those of all previous champions were carved.*

As a token of appreciation on their participation, all participants of the SPC were also awarded a Certificate of Appreciation.

With a view to enhancing the fruitfulness of the event, winners of the First Prize of both the Junior and Senior Sections were invited to present their winning projects and shared with the audience their experience

and gains in the course of preparing the projects. The responses of the audience to the presentations and to the performance of the students were again fabulous.

The SPC would definitely not have been such a success without the collaborative effort and support of various parties concerned. Opportunity is hereby taken to express, on behalf of the Organising Committee, our heartfelt gratitude to Mr. Joseph LEE, Chairman of the Commission on Youth, for being the Patron of the SPC; to Mr. Chris WARDLAW, Deputy Secretary for Education, and Mr. Hing-wang FUNG, Commissioner for Census and Statistics, for being the Patrons of the SPC and the officiating guests of the Ceremony; and to Mr. Leslie TANG, President of HKSS, for being the officiating guest.



*Patrons and Honourable guests at the Prize Presentation Ceremony. (From right: Dr. L.K. LI, Mr. Leslie TANG, Mr. H.W. FUNG, Mr. Chris WARDLAW and Mr. Simon YEUNG)*

This is the first time that HKSS formally co-organised the SPC with the EDB. Besides sponsoring a number of activities, EDB colleagues had paid strenuous efforts and provided unfailing support, which were extremely crucial to the smooth completion of all the relevant jobs. I trust that the collaboration established would be maintained and continued to flourish in the future rounds to come.



*The students shared their experience of participating in the SPC with the Honourable guests at the tea reception after the Ceremony.*



*Teacher and students from N.T. Heung Yee Kuk Yuen Long District Secondary School, winners of the First and Second Prizes of the Senior Section, shared the memorable moment with the Patrons and Honourable guests.*

Given that the SPC has been gaining increasing recognition, I believe that the support to the SPC will be progressively thriven within the community. There is no doubt that the SPC would continue to help equip secondary school students with such capabilities as enhanced statistical literacy and proper use of statistics to meet the new challenges presented ahead of them.



## News

### Department of Statistics and Actuarial Science, The University of Hong Kong – 40th Anniversary Dinner



The year 2007-08 marks the 40<sup>th</sup> anniversary of the Department of Statistics and Actuarial Science, The University of Hong Kong. In celebrating this special occasion, a reunion dinner was held on April 11, 2008 at Loke Yew Hall of the university.

This first ever homecoming event brought back to the family some 400 guests, staff and alumni from various sectors. Professor Wai-keung Li, Head of Department, Professor Lap-chee Tsui, Vice Chancellor and President of HKU and Professor Allan Shi-chung Cheung, Acting Dean of Faculty of Science took turn to deliver an opening speech and, together with other officiating guests, proposed a toast to kick off the festive evening.

Over the course of dinner, a meticulously prepared video was shown to relive the participants' fond memories with the department. Graduates of different eras also shared with the audience their campus stories. Among those included Mr. Linus Yip Sheung-chi, strategist at First Shanghai Securities, and Dr. Philip Leung-ho Yu. The latter also unveiled the 'A to Z' of the Department. The event reached a climax when Mr. Hing-wang Fung, Commissioner of Census & Statistics Department performed the song 'Memory' from the musical 'Cats'. His magnificent voice won loud applause from the audience.



Another highlight of the evening was the souvenir presentation. Professor Li saluted to the eight selected distinguished alumni for their outstanding achievements and contribution to society. The donors and

patrons were also acknowledged for their generosity and support of the Department.

Ending with joy and laughter, the event signified a milestone in the Department's glorious history of the first 40 years.

### **Department of Statistics and Actuarial Science, The University of Hong Kong – Promotion**

Dr. K.C. Yuen from the Department of Statistics and Actuarial Science has been promoted to Full Professor.

### **Compositions of the Council and Various Committees of the Hong Kong Statistical Society**

The Annual General Meeting for the 2007/08 session was held on 13 March 2008. During the meeting, the following members were elected to the Council for the 2008/09 session:

<b>President:</b>	Mr Leslie Tang
<b>Vice-President:</b>	Dr Philip Yu
<b>Treasurer:</b>	Mr Raymond Tam
<b>General Secretary:</b>	Ms Edith Chan
<b>Membership Secretary:</b>	Dr Sherry Zhou
<b>Publications Secretary:</b>	Dr Raymond Wong
<b>Consultation Services Secretary:</b>	Ms Agnes Law
<b>Programme Secretary:</b>	Dr Man-lai Tang

Moreover, various committees of the Society for the 2008/09 session have been formed and their compositions are as follows:

### Organizing Committee of the Statistical Project Competition for Secondary School Students

Chairperson:	Mr Keith Pang
Members:	Dr Li Leong-kwan
	Mr Peter Ip
	Ms Alvina Kwan
	Miss Denise Yeung
	Mr William Lam
	Mr Jonathan Ng
	Ms Christine Cheung

### Professional Services Sub-committee

Chairperson:	Ms Agnes Law
Members:	Ms Marion Chan
	Miss Louis Ng

### Editorial Board of the HKSS Bulletin

Chairperson:	Dr Raymond Wong
Member:	Mr John Lam

### **Upcoming International Conferences**

The biennial conference of the International Association for Official Statistics (IAOS) this year will be held in Shanghai, China from 14 to 16 October 2008. IAOS is one of the seven Sections under the International Statistical Institute (ISI). An integral part of



the conference is also the 26th biennial conference of the SCORUS, the Standing Committee (of IAOS) on Regional and Urban Statistics.

The main theme of the Conference is "Smart Data, Innovative Uses - Reshaping Official Statistics". As a joint conference, SCORUS will be organizing sessions with SCORUS-focused themes on regional and urban statistics. More up-to-date information about the conference is continually being uploaded onto the website of the conference (<http://www.iaos2008conf.cn/index.htm>).

Besides, the International Forum on Metropolitan Statistics is being organized by the Beijing Municipal Bureau of Statistics from 19 to 21 October 2008 which is an international meeting back to back with the joint IAOS/SCORUS Conference to take place in Shanghai during 14-16 October. The main theme of the Forum is "Development of a Metropolis and its Statistical Service". Information about this Forum is also continually being uploaded onto the website at <http://www.bjstats.gov.cn/ddsgjtjlt/english>.